proved by priming, if the yeast is in healthy condition. If there is a preponderance of unsuitable ferments, it is unwise to stimulate their action, and when beers are a little out of health, priming has usually to be dropped. The two principal objects may be attained by two different classes of sirup. Lusciousness by a solution of invert sugar, which also acts as a stimulant to condition; and rapid condition or briskness, where sweetness is an objection, by glucose priming.

The action of the secondary yeasts in breaking down the malto-dextrin, in beer, may be supplemented by the employment of a cold water extract of malt. So powerful is the diastase thus obtained, that half a pound of grist has a distinct influence on 100 barrels of beer. This quantity should be steeped in two pints of water for some six hours and then strained. The diastase liquor is afterward added to the racking back, and well roused in. If there is no racking back and no opportunity of adding it to a large bulk of beer, it can be mixed with several gallons of beer, and the correct proportion added to each cask. With a sufficiency of malto-dextrin in his worts, the brewer thus has a further means of determining the condition of his beers. If intended for lengthy storage, he will wait for the gradual degradation of the body by the cask ferments. If he requires rapid condition, he will employ cold malt extract at racking. The practice of adding malt flour as a priming to stouts is a very old one, but its true significance has only been recently discovered. It acts similarly to the cold water extract of malt, but the latter is decidedly preferable, especially for ales, owing to the absence of husky particles.

Beers that are hopped should always be well rolled every day for about a week before they are topped up and shived down, so that the hops may be thoroughly soaked, and the maximum of absorption obtained. After shiving, they should again be rolled, daily if possible, for at least a week before they are stacked away.

Cleansing in Trade Casks.—By cleansing is meant the elimination of the residual primary yeast before the casks are shived or bunged. The beers are racked a day or two earlier than is customary on the ordinary system, and the temperature should not be cut down quite so low. They are racked into cask with a little life left in them, so that the primary yeast may work out as much as possible through the bung hole. The casks need slight topping up once or twice a day for a day or so, and it is remarkable what an improvement this slight amount of cleansing makes in the flavor and eventual brilliancy of beers so treated. This system also gives very good results with pale ales, with which cleanness is so highly important. If these ales are thus worked, it becomes necessary to postpone the introduction of the hops until the process of cleansing is finished. This may be several days. A little ale has to be siphoned out to make room for them, and it is more convenient to wet them first. After the addition of the hops, the casks should be bunged and rolled occasionally for a few days longer before they are topped up and shived. In breweries where it is difficult to attain satisfactory cleanness at racking, this system is recommended, as it is undoubtedly prejudicial for the beers to be closed down with any large percentage of primary yeast remaining in suspension.

Preparation for Bottling.—Preliminary cleanness is very important in the case of beers intended for bottling. Unless sufficient brightness at racking has been secured, the process just referred to is very beneficial. Indeed, it may be improved upon by bunging down and rolling the casks well every day prior to being topped up. The agitation of rolling enhances the assimilative capacity of the yeast and the elimination of those bodies that cause undue yeast growth in bottle. In the production of beers for bottling it is most important that there should be a minimum of matter that either comes out of solution during the bottle fermentation or stimulates unnecessary yeast reproduction. This essential cleanness can only be satisfactorily accomplished by the aid of sound and vigorous secondary fermentation in cask. After shiving, beers for this purpose should be rolled with more than ordinary assiduity, with a view of obtaining, if possible, spontaneous clarification, the very best proof of natural cleanness. But it often happens that beers which are comparatively clean and have passed through their secondary fermentation will not drop sufficiently brilliant for bottling in the time required. Recourse must then be had to fining. But it is a mistake to suppose that beers are fit for bottling simply because they go bright with finings, unless they have undergone cask fermentation. New beers are certain to throw a heavy deposit, and are very likely to be cloudy in bottle. There is a somewhat popular idea that beers should be flattened before they are bottled. The excess of gas must be let off through porous pegs, but the greatest care should be taken to exclude any air, which is fatal to brilliancy. If fining has to be resorted to, the smallest efficient quantity should be added, and the casks should be allowed to settle for at least a week.

Temperature.—For pale ales and stock beers a moderate one of about 55° F., when it can be maintained, is the most satisfactory. Temperature has a decided influence upon the flavors developed during cask fermentation, in the same way as during primary fermentation. Cells that receive running beers may be somewhat warmer than those used for stock and pale ales; but it is not advisable to allow the temperature to much exceed that which may be expected in the cellars of the consumer, for in winter there is danger of chilling, after fining, which causes lack of brilliancy. This effect of temperature reduction is the result of bodies that are only just soluble at higher temperatures coming out of solution. The cleaner the beers, the less likely this trouble. The heat of the beers at racking ought, as a rule, to be a few degrees lower than the likely temperature of the store. Stock beers may well be several degrees below, as the rise in heat will cause expansion, and so prevent ingress of air through crevices in the casks.

Fining and Sampling.—The use of old beer for this purpose is unsound both in theory and practice. The main point to be observed in the manufacture of white finings is sufficiently lengthy steeping. Good finings cannot be made in a hurry. The glass should be steeped for at least a month before it is passed through the finest sieve. It is a good plan to put the steep through a coarse sieve as soon as the glass is soft enough, as further softening is much hastened. If a little water is added daily, and the mixture is kept

well roused up, it is usually ready for coarse sieving in about a fortnight. In regard to quantities and proportions, much of course depends on the quality of the glass, which may be very variable. With good Penang leaf, a gallon and a half of sulphurous acid and one pound of tartaric acid may be used for every seven pounds of glass. These quantities should make two barrels of white finings, with the daily additions of water made up to a definite strength. This can be tested by the viscosity tester, the time occupied by a definite volume of finings in passing through a small hole giving the comparison required. A definite working standard can thus be easily fixed.

Color.—The question of color is in many breweries a troublesome one. Standard sample bottles are very useful, and may be made with orange aniline dye and caramel mixed. These bottles must be made up with half methylated spirits to prevent settlement and loss of color.

Yeast Pressing.—Where there is a good proportion of stout and porter, there is no trouble in working off pressings at a good profit. It is most important that yeast should not be allowed to get stale, and in some smaller breweries this is the tendency. The most satisfactory plan is, of course, to press every day, and certainly it should not be done less often than twice a week. In summer, if pressings have to be kept some few days before blending, salicylic acid is the best thing to use as a preservative. Sulphites give an unpleasant flavor and smell.

Waste.—Waste is a most unsatisfactory thing to deal with. When, however, there is a demand for aged beers, there is not any trouble in getting rid of it at a good profit; but in many breweries it is impossible to dispose of the entire waste of a public trade by blending, without prejudicing the character of the beer. It often pays best to allow so much per barrel, and to refuse to receive the waste. When they can be worked up, it is usual to vat them, and if this is done, the more hops that are added to the vat, the better.

Returns.—The working up of returns also requires great attention. There are four different kinds: acid, flat, turbid, and casky. The working off of flat returns is the easiest of all. They can be added direct to running beers. Casky returns are practically impossible to deal with, and are best turned down the drain. Some forms of turbidity are very difficult to overcome. They are improved very often by intermixture with acid ones, but when much is returned on this account, it is not wise to blend sour with them, as the acidity may increase, and so enhance the difficulty of blending with mild-flavored ales. Hopping, as suggested in the case of waste, is the best treatment, combined with rolling when the quantity is not sufficient for vating. Time usually brings brightness, and until this has been tried they should not be worked off. Acid returns need very careful working off. They may, of course, be neutralized, but this treatment requires considerable skill, and is not, in my opinion, very satisfactory. They may be heavily treated with salicylic acid, to prevent them from becoming worse. The returns of each day should be regularly tasted and sorted, and the casks should be marked for special treatment according to the complaint; if sour, for soaking, if casky, for the cooper. All little lots should be turned into odd-and-end casks, no ullages should be left on hand, and everything should be done to release as many of the trade casks as possible. If the quantity is large enough to employ a vat, the returns should be pumped over at the earliest opportunity. Everything that is fit to use up at once should be immediately blended off. Acid and turbid returns must remain in cask or vat until practically bright. By daily supervision of the returns, it is possible to greatly facilitate working up, and to avoid a great deal of unnecessary trouble and loss.

Preservatives.—With good malts, sound mashing systems, and thorough cleanliness, preservatives are seldom required, but with doubtful materials, the judicious employment of antiseptics is advantageous. If, however, they are added in excess, much more harm than good accrues, on account of their retarding influence on cask condition, which is so important in regard to stability. The basis of most preservatives is some sulphite, or mixture of sulphites and salicylic acid. Salicylic acid is very useful in many cases, especially for running beers brewed from low-class materials. But for ales that are required to come into early condition, it is not satisfactory. There is an impression that the antiseptic power of the sulphites depends upon their affinity for oxygen, and that they owe their action to the absorption of oxygen existing in the beer. But the change from the sulphite to the sulphate is practically a very slow process, and there is a large excess of oxygen in the beer that cannot be attracted by the small amount of preservative employed; their antiseptic action must, therefore, be due to some more direct influence upon the organism. The sulphates and chlorides present in brewing liquors are, of course, very important natural preservatives, and the additions that are often made to the liquor are very useful, both directly and indirectly, in promoting the stability of the finished beers. But of all preservatives, cleanliness is the best, and without it stability and character are unattainable.

Cleanliness.—In regard to the cleanliness of racking rooms and cellars, much depends on their construction. Cement, concrete, or granolithic flooring and glazed tile walls are, of course, the nearest to perfection. The surfaces of these departments ought all to be constructed so as to admit of thorough washing with a hose. Plain brick walls and old timber should be repeatedly washed with a mixture of freshly burned lime and chloride of lime, the latter at the rate of about one-sixth. For the flushing out of drains, chloride of lime is very useful. It is a good plan to mix some with cold water in an old cask at the rate of about four pounds per barrel. Add one pint of sulphuric acid, previously diluted in a wooden bucket with cold water. Allow the cask to remain for some few hours tightly bunged, and then empty down the drain. All wooden vessels, such as troughs and shoots, should be frequently scalded out, and occasionally painted over with sulphite of lime. Beer mains should have steam connections, and they should be steamed out every time they are used. India rubber hoses are sometimes difficult to keep clean. They must be flushed with cold liquor after use, and then hung up to dry. It is a bad plan to coil them up when damp. Hot liquor cannot be used for hoses without doing

harm, and this is a great disadvantage. They may occasionally be charged with a weak solution of permanganate of potash without injury. All racking stockings should be scalded out every night, and hung up to dry, and a strict rule should be made of having all filling and topping-up cans and buckets well washed every evening, and set in a rack to drain. For the cleansing of wooden vessels, such as vats and racking backs, powdered pumice stone, laid on wet upon the brush, as suggested by Aldous, is very useful. Slate vessels can also be cleaned with it. For vessels of either material an occasional coating of sulphite of lime is beneficial.

PHOTOGRAPHY IN ANILINE COLORS.*

By A. G. GREEN, C. F. CROSS, and E. J. BEVAN.

IT does not require any very refined faculties of observation for the appreciation of the stupendous work continually brought upon the face of the earth by the sun's light and heat. In very early ages this appreciation has been signalized by the deification and worship of this great center of force; and if in these latter days of scientific investigation and exact knowledge we do not allow our feelings to carry us away in contemplating the great luminary itself, or the brilliant and mighty workings of its ceaseless energy, it is only because the struggle for the life which it inspires and sustains is too severe for more than occasional contemplation of the poetic side of the natural order. In the modern art of photography we have much that appeals to our most refined perceptions, both æsthetic and scientific, and the new photographic process which we have undertaken to bring to the notice of the Society affords an occasion, apart from its more direct application to æsthetic and utilitarian ends, not merely of extending our grasp of the results of modern science, but what is more important, of the phenomena upon which they are based. Our ordinary inquiries as to these results are too often limited to extrinsic considerations; we find them useful or beautiful, or both, and that is sufficient. The scientific spirit, on the other hand, leads us beyond the region of sensuous impressions into that of the ultimate components of matter and of force—an unseen world, but far more real to the scientific imagination than the visible arena of gross or aggregate results. If we are to understand how it is that light can so affect matter as to be able to impress itself by bringing about a permanent change in its composition—which is the essential idea of photography—we must know what are the ultimate reacting elements, dynamic and material. The factors of the problem are the *light*, or agent; the sensitive substance or matter acted upon; and the third, the inevitable *tertium quid*, or *medium* through which entities so totally distinct as force and matter are brought into reactive relationship.

We will begin with a few elementary considerations as to the nature of light.

To ordinary visual observation, a beam of sunlight is homogeneous luminosity. Most of us, on the other hand, are doubtless aware that science gives a very different account of solar radiation from what might be reasoned from mere sense impressions, showing it to be a highly complex aggregate of force—elements differing widely, not only in their dimensions, but in the phenomena to which they give rise. We may prepare the way for a short description of the results of analyzing solar radiation, and observing its ultimate components in detail, by an illustration taken from more familiar sources.

When we speak of the English army, we may think of it as the collective expression of the physical force of the English people; but when we think of the army in action, we picture infantry, cavalry, and artillery; and, further, each of these armaments made up of the actual fighting units or individual soldiers. So with solar radiation. We find it active in three distinct directions, giving rise to the effects of heat and chemical action, in addition to those of light; and that these aggregate effects—observable in the aggregate by the senses—are caused immediately by the unit constituents or force elements, of which we come now to speak more particularly. If we cause a convenient section of sunlight to pass through a prism of glass or crystal, we bend the light out of its course, and, as an additional result, it is decomposed into a band of colored light—the solar spectrum. In other words, the several constituents of solar radiation—thus spread out or separated—are affected by the prism in the order of their dimensions; and, in corresponding order, they affect the organ of vision, giving rise to the succession of color effects with which we are familiar in the rainbow. That these colored lights are the actual constituents of white light is easily proved, by causing them to pass through a second prism, conveniently disposed, so that the bending or dispersion may be reversed. From this second prism a beam of pure white light emerges.

On further examining the spectrum, we find that not only do the light effects vary from point to point, but that effects of heat and chemical action, which are caused by the constituents of solar radiation, also vary considerably. The heat rays we may regard as localized at the red end of the spectrum, extending considerably beyond the visible limit. The chemical activity of the spectrum, on the other hand, we cannot regard as localized, excepting for particular effects. Thus, for the more familiar processes of photography, the chemical effects upon which they depend are chiefly produced by rays situated toward the violet end; whereas in the photographic process which forms the subject of this communication a much wider range of activity is discernible, extending from the violet through the green, well into the orange portion of the spectrum. We shall revert to this, the more important part of our subject, after saying a few words as to the actual nature of the solar radiation, which manifests itself to us in this three-sided activity.

The older view, that it was a kind of matter emitted by the sun and transmitted to us through space, is no longer held; this cruder view has given place to the undulatory theory of the nature of radiant energy, according to which it is an undulatory disturbance or a wave motion in what is called the universal ether. With regard to this ether, we need only observe that the propagation of a motion through space postulates a transmitting agency or medium, and the enormous

* A paper recently read before the Society of Arts, London. From the *Journal of the Society*.

velocity of its propagation—186,000 miles a second—postulates a medium of very high elasticity. And this ether must evidently pervade all substances; how otherwise could we have the property of transparency or light transmission?

With regard to wave motion, we can only put forward one or two elementary considerations to enable those who have not considered the subject to form some mental picture of the effect. If we twist a cork-screw, we notice a propagation of a wave in the direction of the axis; this wave evidently is one of *form* only, as there can be no translation of the substance of the screw. The effect of wind upon a piece of standing corn is to create a succession of waves, which, again, are waves of form caused by the oscillation of the individual stalks to and fro in regular succession. Lastly, the waves of the sea are not caused by a forward movement of the body of water; it is an appearance of movement of this kind, but, actually, the disturbance of the water, *i. e.*, of the water particles, is in the vertical plane, that is, up and down. We will illustrate waves of this kind by means of a mechanical diagram, and conclude our brief description with the lucid definition of wave motion by a well known author as a continued transmission of a relative state of particles, their motion separately considered being, on the other hand, a reciprocating motion. Such we will take to be the nature of the waves of radiant energy. The lengths of these waves vary from point to point of the solar spectrum from 0.0000193 inch in the red to 0.0000999 inch in the violet. Remembering that the velocity of propagation of the disturbance is 186,000 miles per second, we may reckon the number of wave impacts per second upon an illuminated surface, arriving at numbers which surpass our mental grasp. We have now to inquire how the bombardment of these infinitely tiny waves can effect chemical decomposition, can undo the combination of matter with matter, producing in certain substances those changes which give, either directly (when a color change is directly produced) or by development (where colored compounds can be built up upon the surface affected by the light), photographic pictures.

If we bring together such a metal as silver—a simple or elementary substance—and the elementary gas chlorine, combination instantly ensues, attended by considerable evolution of heat. The product is a white compound devoid of metallic luster, and altogether different in external properties from either of the elements which have combined to produce it. Now, how can we decompose this product, chloride of silver, and restore the silver and chlorine to the free state? By putting back into the compound the energy of force which was set free and lost in the act of combination. This we can do in two ways. By means of the electric current or by the action of light.

The former admits of easy demonstration. Thus, on taking a suitable solution of the chloride, and inserting two copper plates connected at the terminals of a galvanic battery, there is an instant deposition of silver on the one, and the chlorine goes to the other plate. Now, the well known darkening of silver chloride on exposure to light is actually not so simple a resolution as that which we have demonstrated, but, essentially, it is the same. The darkened product is richer in silver than the original, and chlorine may be easily demonstrated to be set free in the process.

And this is a typical case of the action of light. It is an addition of energy to a compound, and an undoing thereby of the act of combination by which it was produced. Witness the stupendous work accomplished by light in building up the vegetable world around us. The raw material which is employed by nature is the carbonic acid of the air—a compound of carbon and oxygen. This it decomposes in the plant cell, restoring the oxygen, and building up the carbonaceous residue into the structure of the plant. To understand how the infinitely tiny waves of light which have no weight can tear asunder masses of substance, such as silver and chlorine, requires an exercise of imagination. There is an enormous weight of evidence to prove that all matter is made up of infinitely small masses, all equal, and equally endowed with the properties which mark the substance. These are the atoms of the chemist. These are in active motion. Chemical combination is a coming together of atoms. The heat and light evolved in combination is the result of the atomic collisions; and in consequence of the collision there is a loss of motion. It is these atoms—which are freely accessible to the all-pervading ether—which respond to the impulses of the waves of radiant energy; and it is in this invisible region, remote from sense impressions, that the phenomena which we are about to consider take place.

We shall confine ourselves to processes based upon the aniline or coal tar colors, since we find them completely typical of photographic processes generally.

The simplest method of producing a picture in any of these colors is based upon the familiar observation that these colors—dyed upon fabrics—all fade more or less on exposure to sunlight. This destruction is a complicated action, and therefore we shall not attempt to examine it in detail. We shall content ourselves with exhibiting prints obtained by exposing to sunlight, paper coated with two dyes, which we select as specially fugitive, *viz.*, eosine and methylene blue, under glass positives, as in any of the ordinary and familiar printing methods.

In these prints the gradations of shade are exactly reproduced; those portions which received most light are the most bleached whereas the shadows of the object have protected the portions of paper beneath them, and by the preservation of the color the depth of shadow of the original is reproduced. We need scarcely point out that such a method of photography has no practical value; not only is a prolonged exposure necessary, but the prints, in addition to being somewhat unsatisfactory in themselves, have this disadvantage—that, under the ordinary conditions of exposure, the color will continue to fade over the whole surface, with the gradual obliteration of the picture.

What we want to make such a process practically available is a compound possessing (1) a high degree of sensitiveness and (2) the property of entering into combination with some other compounds giving a product which will resist the further action of the light.

In the diazotype process, which is the main subject of this paper, we have as the actual photographic agent not only a highly-sensitive compound—highly

sensitive, that is, to the action of light—but one which can be readily converted into a variety of coloring matters.

The process consists of four stages: (1) Dyeing or coating the surface upon which it is required to photograph with a particular compound, which is then (2) converted into a photo-sensitive derivative, and (3) exposed to the light under the usual conditions for giving the picture; (4) converting the sensitive compound wherever it survives, through having been protected by the shadows of the object photographed, into coloring matters; thus the picture is developed from the weakly-colored sensitive compound into well-marked shades of red, orange, brown, purple, or blue; and these shades being formed in stable coloring matters, the picture is at the same time fixed.

For the better understanding of the process it is necessary that we should acquaint ourselves with the properties of these substances apart from any reference to photographic action.

The compound we start with is a yellow-colored body,* to which the "trivial" name of primuline has been given. This compound is obtained by the action of sulphur upon toluidine, a coal tar base closely allied to aniline. In this action not only is there combination with sulphur, but several molecules of the toluidine are built up into one complex molecule.

Thus to express the matter in our modern formulæ, we start with $C_6H_5 \cdot CH_3 \cdot NH_2$ toluidine, and obtain—

primuline base. A very formidable-looking compound. Now the important part of this formula to us is not the unwieldy body, but the head, the small group NH_2 . We can consider primuline in its simplified form $X \cdot NH_2$, and we see that this differs from ammonia, $H \cdot NH_2$, in having one H replaced by a complex group. Corresponding to this general resemblance, there is a similarity in their distinguishing property; both are basic or alkali-forming substances, and combine with all acids to form salts. One only of these we have to consider, that by combination with which the stable primuline—highly resistant to all agencies which destroy the more fugitive coloring matters—is converted into a photo-sensitive derivative. This acid is nitrous acid HNO_2 . Nitrous acid and ammonia combine to form ammonium nitrite. When this nitrite is heated, it is resolved spontaneously into nitrogen gas—the inert constituent of atmospheric air—and water.

Now primuline, in common with all coal tar bases, combines with nitrous acid to form a species of nitrite, which is termed a diazo compound. All that we need note about these diazo compounds is that they correspond to the intermediate stage in the transition of the ammonium nitrite to the condition of nitrogen (and water) thus:

These diazo-derivatives are, as a class, sensitive to light, undergoing decomposition with evolution of nitrogen gas. But what concerns us for the moment is their avidity for constructive or synthetic reaction with two large groups of coal tar compounds—the amines and phenols. With these they combine very much as the original bases combine with nitrous acid to form these active diazo compounds, and the products are the azo-coloring matters. We cite the more important of these, obtained from primuline. In the case of the several phenols, their alkaline solutions are employed; while in the case of the bases, acid solutions are used:

Primuline and nitrous acid give diazo-primuline, and diazo-primuline with—

β Naphthol.	Phenol.	Resorcin.	Pyrogallol.	α Naphthylamine.	Amido. β Naphthol
Red.	Yellow.	Orange.	Brown.	Hydroc.	Sulphuric acid.
				Purple.	Blue.

These relations we demonstrate with diazo-primuline and the several reagents above mentioned.

We now come to the photographic application of these reactions. The essential condition of primuline photography is (1) that these reactions take place with primuline after its application to any surface or material, such as wool, silk, etc., as a dye, without in the least affecting its union with the material; and (2) that the diazo derivative produced, in combination with these materials, by treating the primuline-dyed surface with nitrous acid, is photo-sensitive in the highest degree, far more so, in fact, than the derivative itself, when free or uncombined.

Having thus prepared the way, we proceed to a complete experimental demonstration of the process. We first show the building up of the coloring matters upon the cotton and silk fabrics, showing that the reactions take place in silk without disturbing the union between the coloring matter and fabric; and that the azo coloring matters so built up withstand the action of boiling soap.

We have now to demonstrate the sensitiveness to light of a surface dyed with primuline, and sensitized by treatment with nitrous acid, and we shall show that the action of the light is to destroy the diazo derivative, that this destruction is due to the splitting off of its two characteristic nitrogen atoms in the gaseous form. We are enabled to show this to an audience owing to the curious fact that in a gelatine medium the nitrogen, though liberated from combination, is not evolved until the gelatine is softened by contact with water. We expose a primuline-gelatine plate to photographic action, and on plunging into a transparent bath of water, an image of which is thrown on the screen, we see the form of the print instantly developed in minute bubbles of gas. On then treating the plate with one of our developers, we see that when the gas has formed—the evidence, *i. e.*, of the destruction of the diazo-primuline—there is no development of color takes place.

We now develop a number of prints which have been exposed in the daylight, and brought here in the con-

* Discovered by A. G. Green, in 1887. See "J. Soc. Chem. Ind.," 1888, 179.

dition in which they left the printing frame. In these developed pictures the high lights are represented by the neutral tint—varying from buff to cream—of the product of destruction of the diazo derivative, the absence of development in these portions being due to the chemical inertness of this product.

The development of colors corresponding to the shadows and half tones of the object is exactly proportionate to their depth, to the degree of protective action which they have exerted on the sensitive surface beneath—in other words, to the quantity of diazo-primuline which survives.

Reverting to the considerations which we advanced in the early portion of this paper, we should explain the action of the light as an addition of energy or atomic motion to the molecule of the diazo-primuline, whereby the split or cleavage of the molecule at the point occupied by the two nitrogen atoms is determined, just as by adding heat to ammonium nitrite its molecule is resolved into nitrogen and a residue, which in this case is not a complex compound, but water.

We have already alluded to the fact that the rays which attack the diazo-primuline are by no means confined to the blue and violet constituents of the spectrum, but extend well through the yellow to the orange red. In other words, a primuline print is more nearly a measure of the visual intensity of the sun's rays than the sensitive substances used in the ordinary methods of photography, in relation to which it is well known that the photographic intensity of sunlight is a very different thing from visual intensity, owing to the enormously greater activity of the blue and violet rays—*i. e.*, those of least visual intensity—in decomposing the compounds which they employ.

It will be convenient here to point out another contrast of this method with those more commonly employed. The prints obtained with it are positives, the light and shadow in the object being exactly produced in the colored picture. Natural objects, therefore, of convenient form, such as leaves, may be photographed directly; reproductions from camera pictures require glass positives, or positive paper prints made transparent in the usual way with vaseline.

In view, perhaps, of the chemistry of the method, it would perhaps be more correctly termed a negative method, since the action of the light is destructive, and where it acts, the construction or development of the color is rendered impossible. In the ordinary methods, on the other hand, the light is an agent, as it were, in the synthesis of color—where there is most action the deepest tones are developed—and the photographic action would in this case perhaps be more correctly termed positive. The point, however, is not a very important one.

There now remains to be noticed a second photographic process based upon the peculiar properties of the diazo derivatives of the coal tar bases; a method which, to use the ordinary term, is a negative one, *i. e.*, the light plays a constructive part in the development of a colored picture.

When the diazo compounds are treated with an alkaline bisulphite, they are converted into the diazo sulphonates. These compounds are sensitive to light, the action of which is to set free the diazo group from its combination, but they do not react with phenols and amines, as do the diazo compounds. The mixture of a diazo sulphonate with the latter is unattended by any color reaction, but, on exposure to light, the diazo group being set free in presence of a phenol, the development of an azo color takes place *pari passu*. This reaction is the basis of the process invented and patented by A. Feer. The photographic surface is a mixture of a diazo sulphonate with the alkali compound of a phenol applied to any suitable material. On exposure to light under a transparency, development of color takes place in proportion to the quantity of light transmitted, giving, therefore, a reversed reproduction, or negative picture. When printed, the unattacked mixture is dissolved away by copious washing, leaving

the picture, already developed in the azo color, which is relatively insoluble, permanently fixed upon the fabric or material.

The process is not rapid enough to admit of being conveniently demonstrated by means of the artificial light at our disposal. We must therefore content ourselves with this brief description, referring those who wish for further information to the specification of the original German patent, No. 53,455/ga.

In concluding our brief sketch of this new departure in the application of the coal tar colors, we need not, perhaps, apologize for its brevity. We learn that our friend, Professor Meldola, is to give a course of Cantor lectures on "Photographic Methods," and his survey of the field will be wide and complete. We have not attempted to give a general account of photographic methods partly on this account, and partly, also, because these diazotype processes are entirely typical of all printing processes, and, as subjects of lecture or educational demonstration, have the great advantage of involving the very simplest reaction possible; whereas, the changes which take place in silver compounds are very complicated, and as yet but imperfectly understood.

The primuline process is simplicity itself. It can be practiced with the minimum of apparatus, and requires no technical training. The results are striking and pleasing, as we hope to have been able to show.

We cannot conclude without a cordial expression of our indebtedness to the chairman, Captain Abney, for very valuable assistance in investigating the physical elements of the subject. The results we have only been able to glance at in a lecture of this scope. They will be dealt with in full at another time and place.

To the Autotype Company, through their manager, Mr. W. S. Bird, we would also express our thanks, for the loan of positives, and for other kind assistance.

In the discussion which followed, Mr. Cross said the yellow could not be entirely avoided with primuline. It was as essential to the product of decomposition by light as primrose yellow to the original primuline; but this was only the beginning of an entirely new development, and they had already succeeded in getting prints with other bodies

of this class, which gave a very satisfactory approximation of the colorless ground which was such a desideratum for a large class of work. He did not quite understand the question how it was to be applied. They had printed from ordinary photographic positives; prints might also be taken from natural objects, such as ferns, leaves, etc., or an over-printed bromide print might be made transparent with vaseline, and it would yield a very satisfactory print. The applications were absolutely general, so far as photographic printing was concerned. It was for the future to decide what applications of it might be made by amateurs, ladies and others. The process was exceedingly simple; it required absolutely no technical training, and the minimum of apparatus. The fabrics would stand washing in boiling soap solution; and it seemed to him that here was an immense field open for the beautifying of dwellings, which it was for the pub-

had been shown that evening, he had no doubt. The operation could be carried on, not, perhaps, in the drawing room, but in the parlor; the apparatus being very simple, and the materials harmless. They were much indebted to these gentlemen for bringing forward this subject. It was not every day that a new photographic process was brought forward, but this was absolutely new, and as a photographer he hailed anything which added to their knowledge of the means of producing pictures of any description. Unfortunately, it was not quite sensitive enough at present for the camera, but they could not say how far it might be developed. They had long been talking about photographing in colors, and something had been done in that way with carbon. This was not photographing in natural colors, but gave the means of producing prints in a great variety of tints, and without that nicety of manipulation which the carbon

The results obtained by the Chisholm are of interest to Americans in several ways. Not only does it prove that our waters are adapted to the use of the beam trawl, but also that a means is afforded for the capture of two species of fish not hitherto utilized, the pole flounder, believed to be identical with the cock sole of Europe (*Glyptocephalus cynoglossus*), and the lemon sole (*Hippoglossoides platessoides*).

Professor Goode, in his work on American food fishes,* speaks as follows regarding these species:

"The pole flounder, often known as the deep sea flounder, was first observed on this coast in 1877, when numerous specimens were obtained by the United States Fish Commission, in the deepest part of Massachusetts Bay. Specimens have since been obtained south of Cape Cod, at a depth of one hundred fathoms or more, by the Fish Commission, and Prof. Agassiz, off the entrance of Delaware Bay, at a depth of three

THE LEMON SOLE, OR SAND DAB. (HIPPOGLOSSOIDES PLATESSOIDES.)

THE COCK SOLE, OR POLE FLOUNDER. (GLYPTOCEPHALUS CYNOGLOSSUS.)

lie to make use of. Some of the prints exhibited were from glass positives lent by the Autotype Company; and a pretty wide range of objects had been selected. Primuline, as a dye, was invented two years ago, and had been used, to a large extent, by dyers; but its photographic application was a novelty. In conclusion, he had only to say that any one who was interested in the matter might obtain more detailed particulars by calling at his laboratory.

The chairman said he had worked a little with this process, and had been very much fascinated with it, and would recommend every one to introduce it to the ladies of their households, as a perpetual source of amusement, and a means of decoration. They knew how fond ladies were of occupying their leisure time in quasi-artistic pursuits of this character, and here was a method by which they could give a high decorative quality to their cushions and other articles by printing natural subjects upon them. They would be able to group ferns and leaves together into much more artistic combinations than the specimens which

process required. He concluded by moving a hearty vote of thanks to the authors of this paper.

THE ADOPTION OF THE BEAM TRAWL IN THE UNITED STATES.

THE arrival at Boston, Mass., on March 30, of the beam trawling schooner Mary F. Chisholm marks a new era in the fisheries of this country, and is an event not unworthy of notice. Beam trawling, while quite a common method of fishing in England and Europe generally, particularly of the countries bordering on the North Sea, has never been adopted in the United States, because it was generally supposed that the fishing areas of New England were unfitted for its successful use. Heretofore, Americans have confined their labors to the use of hand lines, trawls or long lines, nets, etc., in the deep sea fisheries. From the success of the Chisholm, however, it is but fair to assume that this new method will be in almost general use in a few years.

hundred and ninety-five fathoms. The pole flounder appears to be a permanent resident, throughout the whole year, in the deep basins of Massachusetts Bay and on the edge of the continental slope, and is found abundant in Bedford Basin, the inner expansion of Halifax Harbor, at a depth of thirty-seven fathoms. It ranges nearly to Greenland, and is also found on the coast of Northern Europe, where it appears in Trenchjem Fjord, in latitude 65°, and south to the coast of Ireland. Its thermal range appears to be confined by the limits of 34° to 45°.

"It breeds abundantly in our waters in summertime. Numerous individuals, full of spawn, and young from half an inch upward, have been taken, from July to October, in various localities.

"The pole flounder has been pronounced, by all who have tasted it, a most delicious food-fish, resembling more closely than any other species on our coast the English sole, having a great quantity of peculiarly

* "The Fisheries and Fishery Industries of the United States." By G. Brown Goode and associates.